



LEIR Cooler Status

Gerard Tranquille, AB Dept., CERN

On behalf of the ECOOL/LEIR commissioning team.

COOL05, Galena, IL USA
18th-23rd September 2005



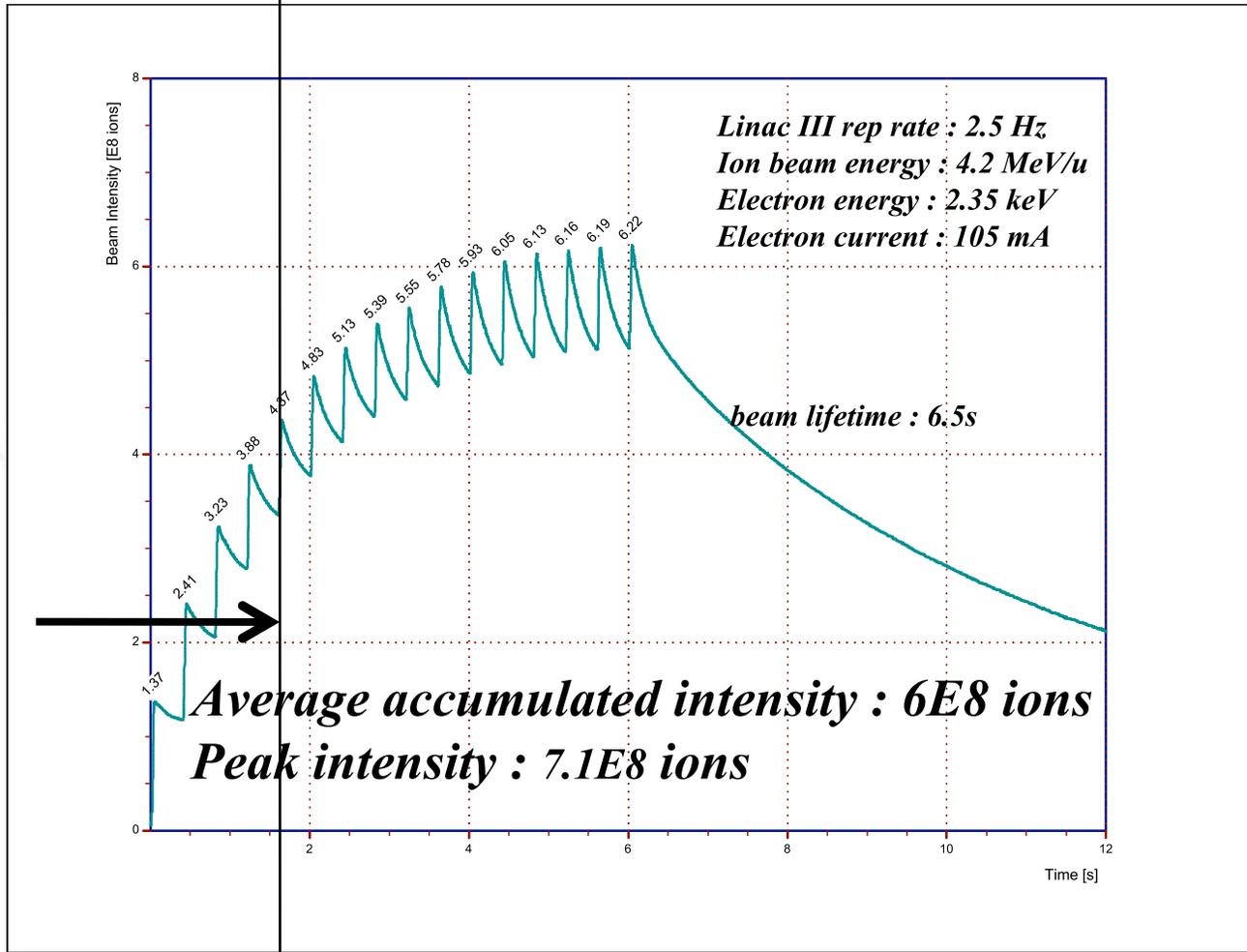
The ions for LHC project



- LHC needs $L = 10^{27} \text{ cm}^{-2}\text{s}^{-1}$ at 2.7 TeV/n
- 592 bunches, $7 \cdot 10^7$ ions/bunch, $\epsilon = 1.5 \text{ } \mu\text{m}$, $\beta^* = 0.5\text{m}$
- Implies $9 \cdot 10^8$ ions with $\epsilon = 0.7 \text{ } \mu\text{m}$ every 3.6s in LEIR
- First run, early scheme, $L = 5 \cdot 10^{25} \text{ cm}^{-2}\text{s}^{-1}$ (60 bunches, $7 \cdot 10^7$ ions/bunch, $\beta^* = 1$) $\Rightarrow 2.25 \cdot 10^8$ ions in LEIR.



Nominal beam

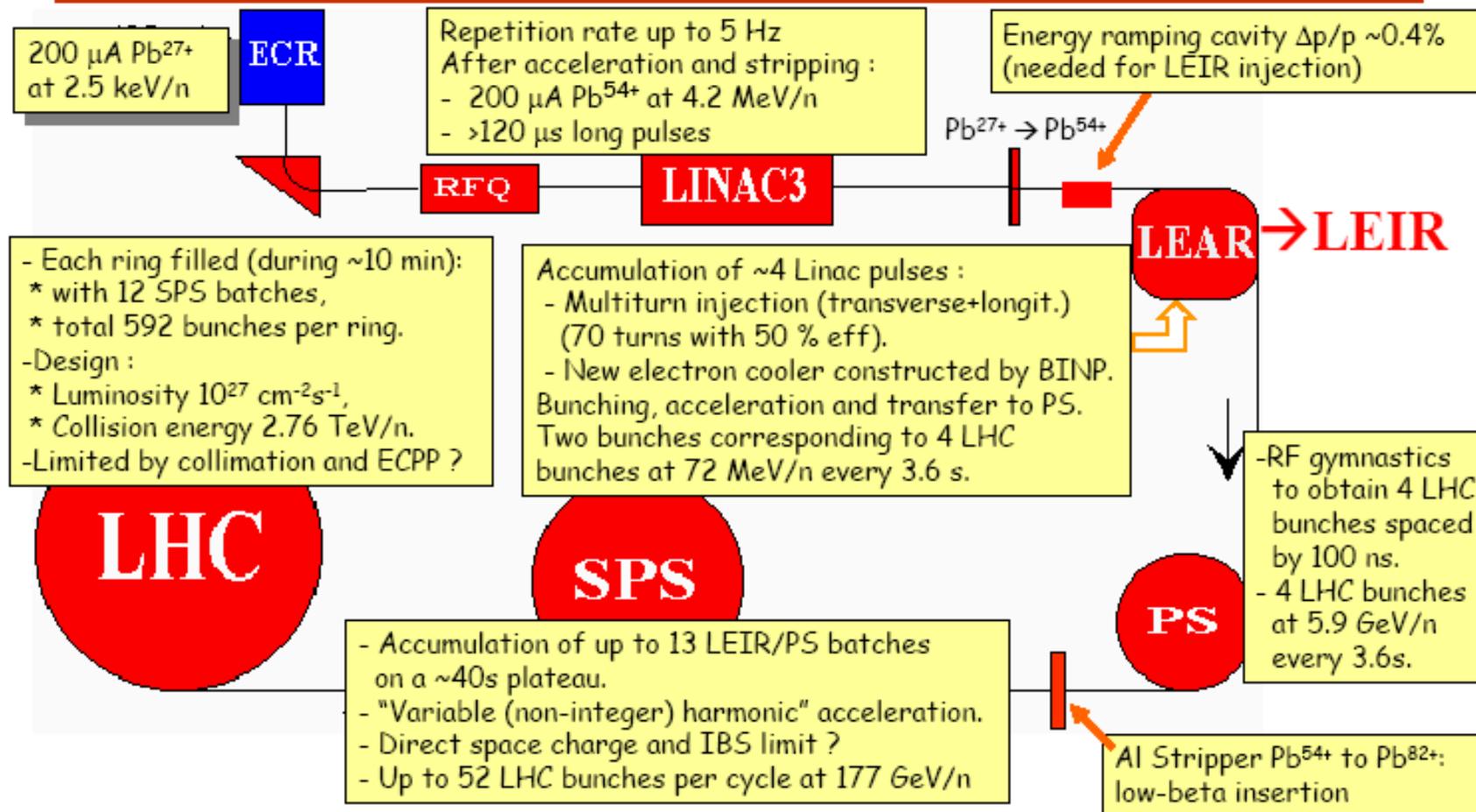


Early beam

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Overview of the Accelerator Chain for (nominal) LHC Ion Operation



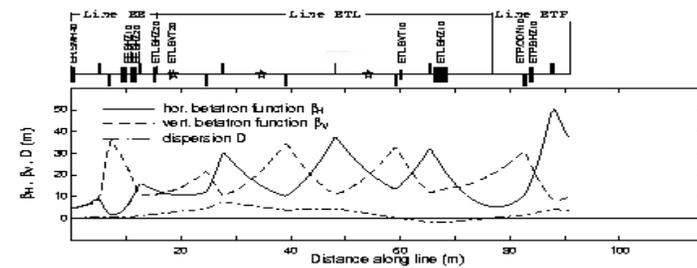
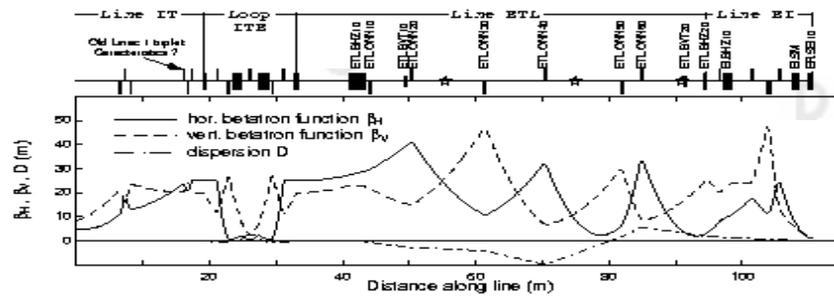
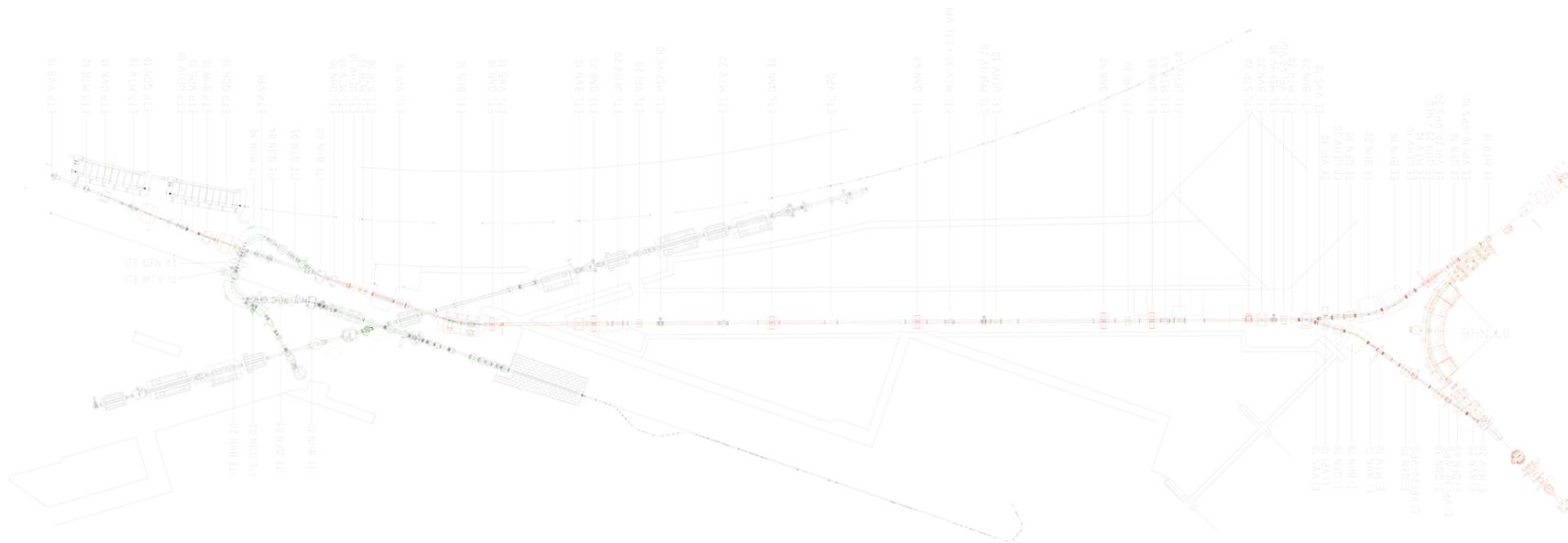
Low Energy Ion Ring LEIR

2/10

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LINAC3 – LEIR in(e)jection line



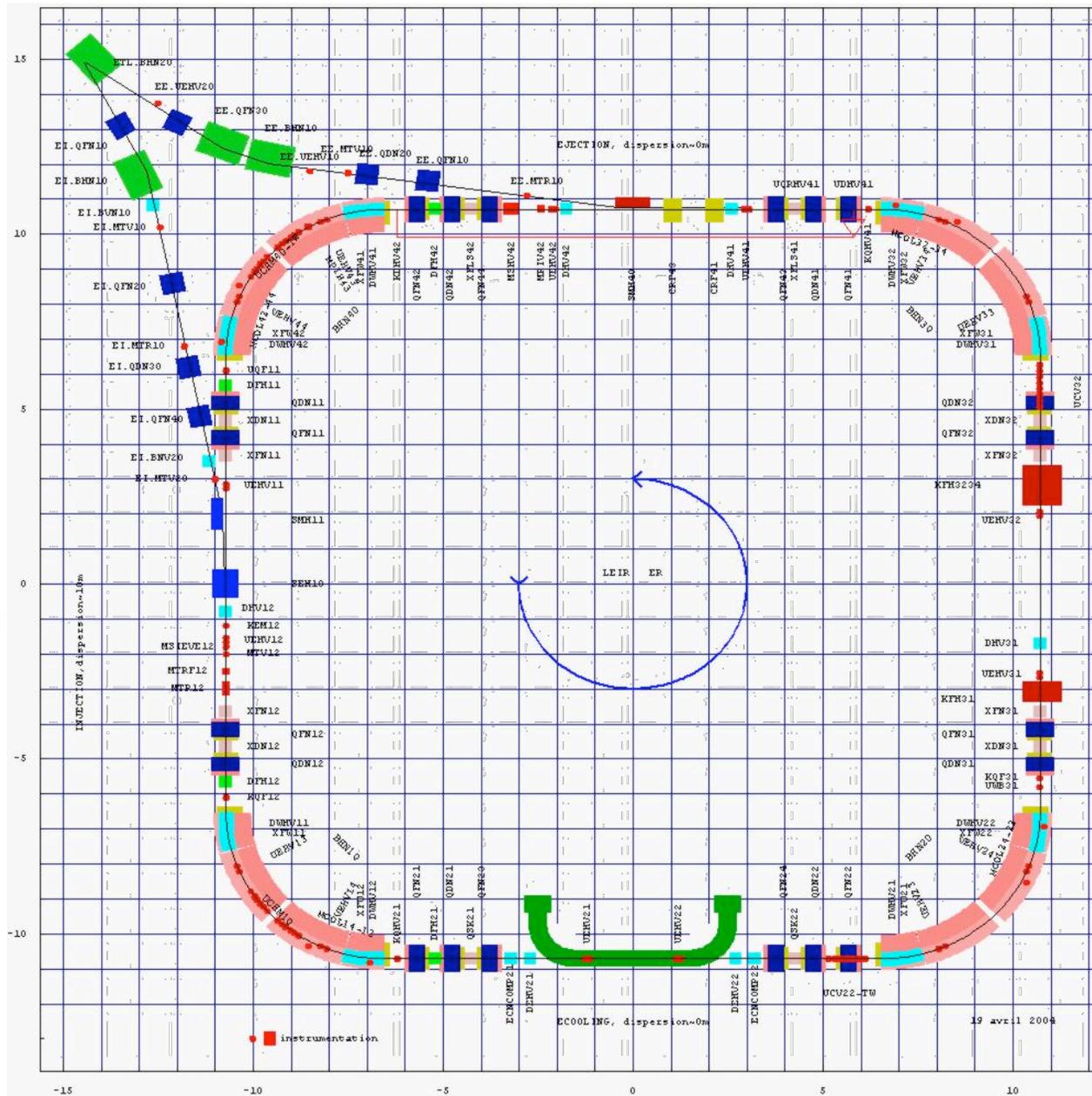
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LEIR



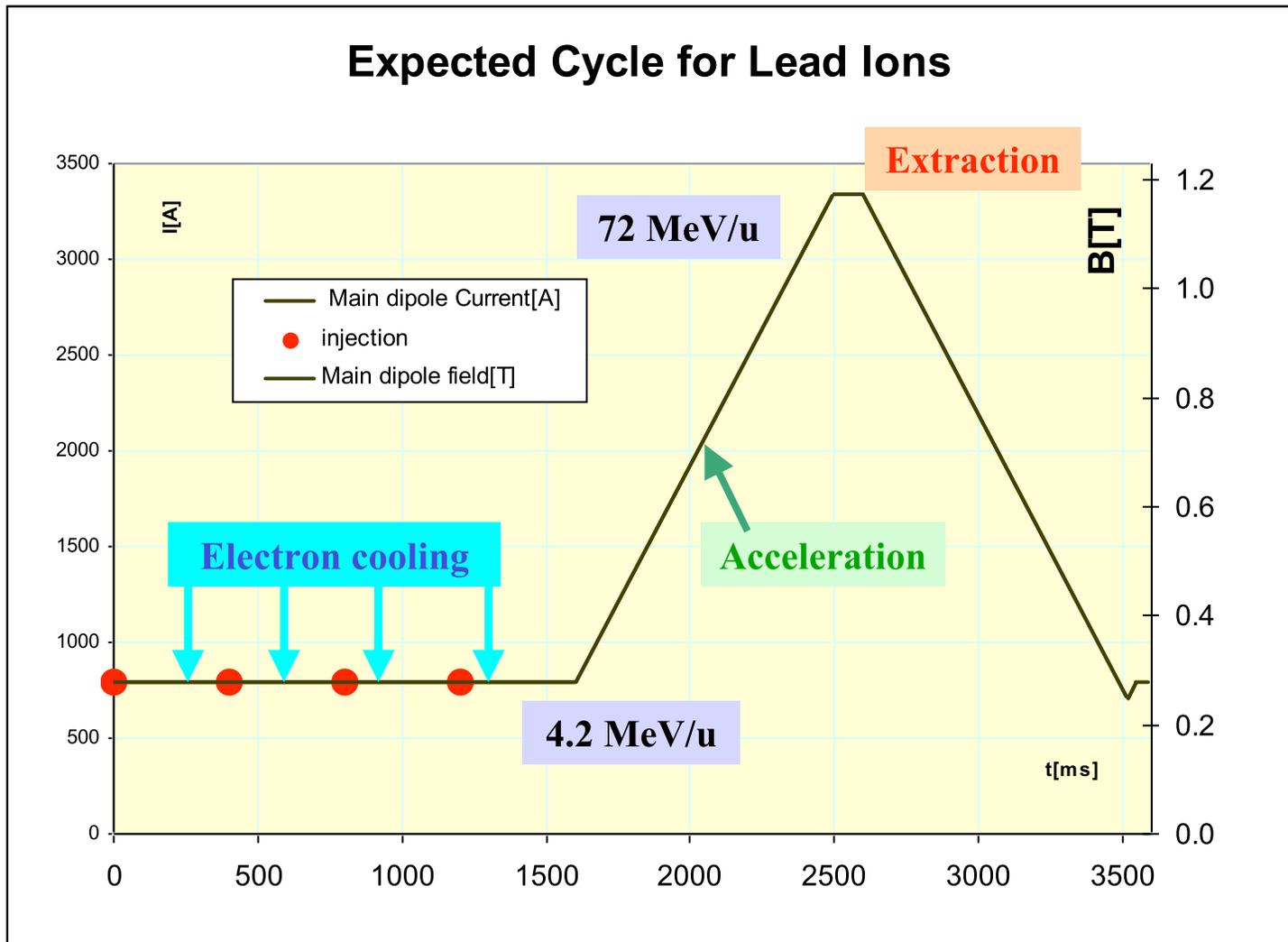
- Combined H/V/P multiturn injection (inclined septum+ momentum increase of incoming beam such the injection orbit ($D \delta p/p$ +decreasing bump) remains the same during injection. 50% injection efficiency reachable(75% on paper))
- Cool and stack the freshly injected beam by electron cooling in 400 ms max
- 4 injection-cooling-stacking cycles should be enough (time<1.6s)
- Acceleration and ejection ($h=2$) at $T=72\text{MeV}/n$ (energy choice is a compromise between the limit of incoherent tune shift in PS, the time between bunches for the ejection kicker, the min RF frequency in PS and the stacking time in SPS/LHC)



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Expected Cycle for Lead Ions



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LEIR electron cooler



- Choice of parameters based on the results from the 1995-97 experiments and on our experience of operating electron cooler devices (LEAR/LEIR, AD) for more than 12 years.
- Electron energy range from 2 keV to 40 keV.
- High perveance gun ($6 \mu\text{P}$ at 2.3 keV $\Rightarrow I_e = 600 \text{ mA}$).
- Variable electron beam density.
- Cold electron beam, $E_t < 100 \text{ meV}$, $E_{\parallel} < 1 \text{ meV}$.
- Adiabatic expansion.
- Maximum cooling length possible. 2.5m.
- Homogeneous magnetic guiding field ($\Delta B_t / B_{\parallel} < 10^{-4}$).
 - “pancakes”.
- Efficient collection of the electron beam ($\Delta I_e / I_e < 10^{-4}$).
 - Electrostatic deflector plates.



- Technical specifications made in 2001/2002.
 - LEIR electron cooler conceptual study, PS/BD/Note 2001-17.
 - Specifications for the LEIR electron cooler magnetic components, PS/BD/Note 2002-18.
 - General mechanical parameters for the LEIR electron cooler, PS/BD/Note 2002-23.
- Design/feasibility study completed by BINP in March 2003.
- Addendum to the CERN-Russian Federation Agreement (“Skrinsky II”) approved in May 2003.



Gun



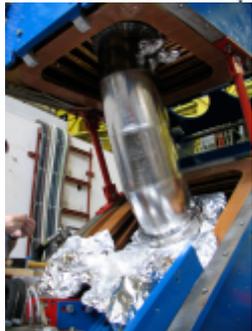
Collector



A

G

Cooling section



C

D

E



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- Technical drawings approved in autumn 2003.
- “shopping list” drawn up at the same time.
- First shipment of materials (316LN steel, bellows, HT feedthrough, water hoses and connectors) to Novosibirsk made in March 2004 with a complementary delivery in June.
- Construction of vacuum chambers and magnet system (“pancakes”) made in the BINP workshop.
- Magnet measurements and alignment made in October.
- Test with electron beam performed in November



August 2004



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October 2004

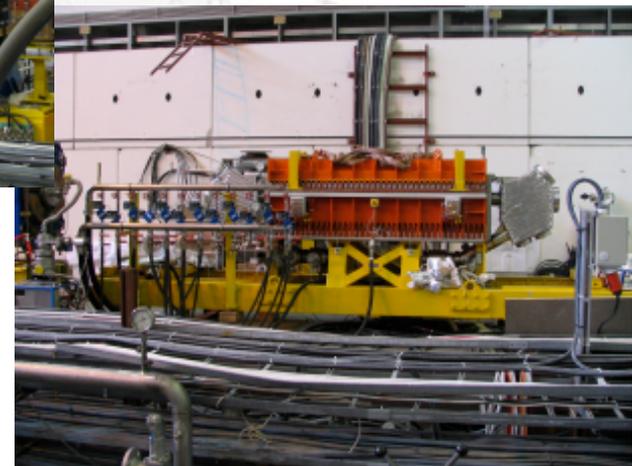
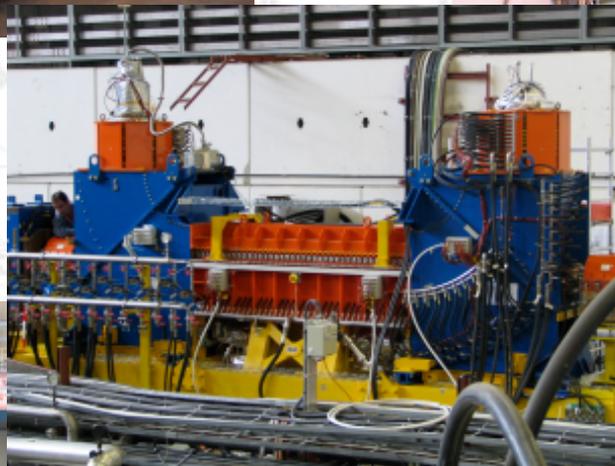


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- Cooler arrived at CERN on December 16th 2004.
- Jan. – May:
 - Vacuum system cleaned
 - Modifications made to water and HT systems
 - Faraday cage installation
 - Interlock system commissioned
 - Solenoid power supplies commissioned
 - Magnet measurements made
 - Ensemble inserted and aligned with the LEIR ring
 - Preparation for bakeout

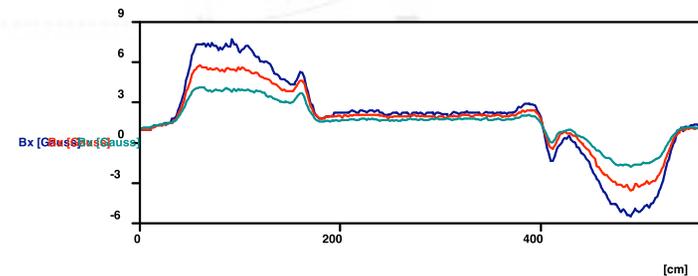
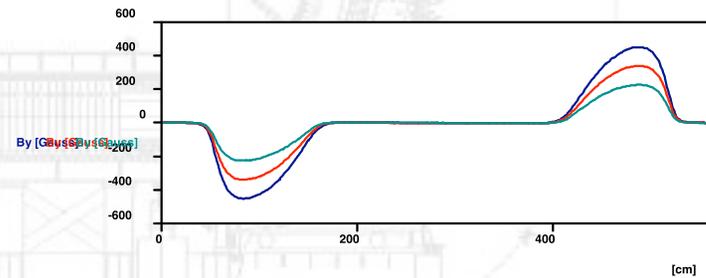
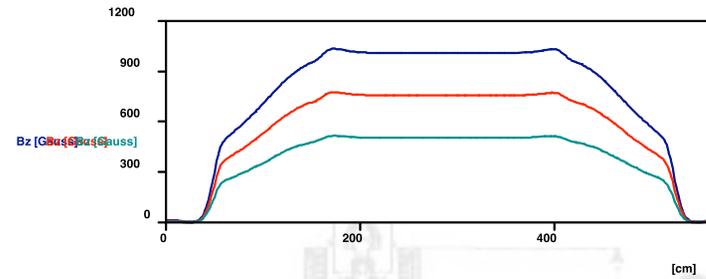
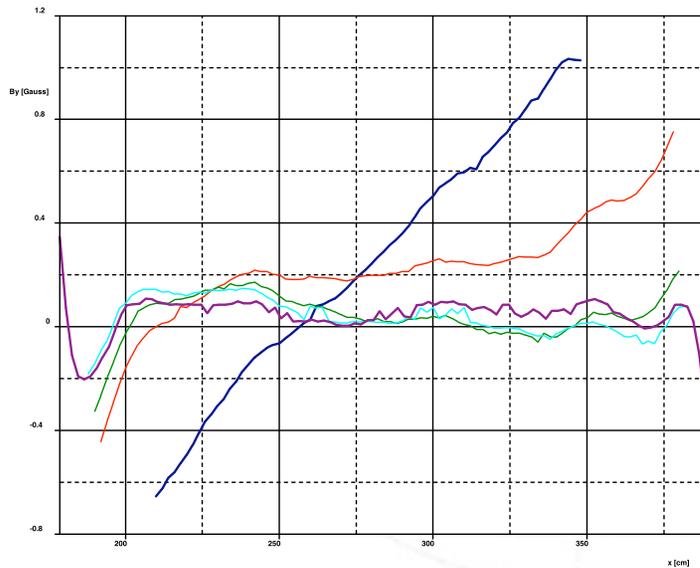
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Magnetic Field Measurements



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Bakeout Cycle

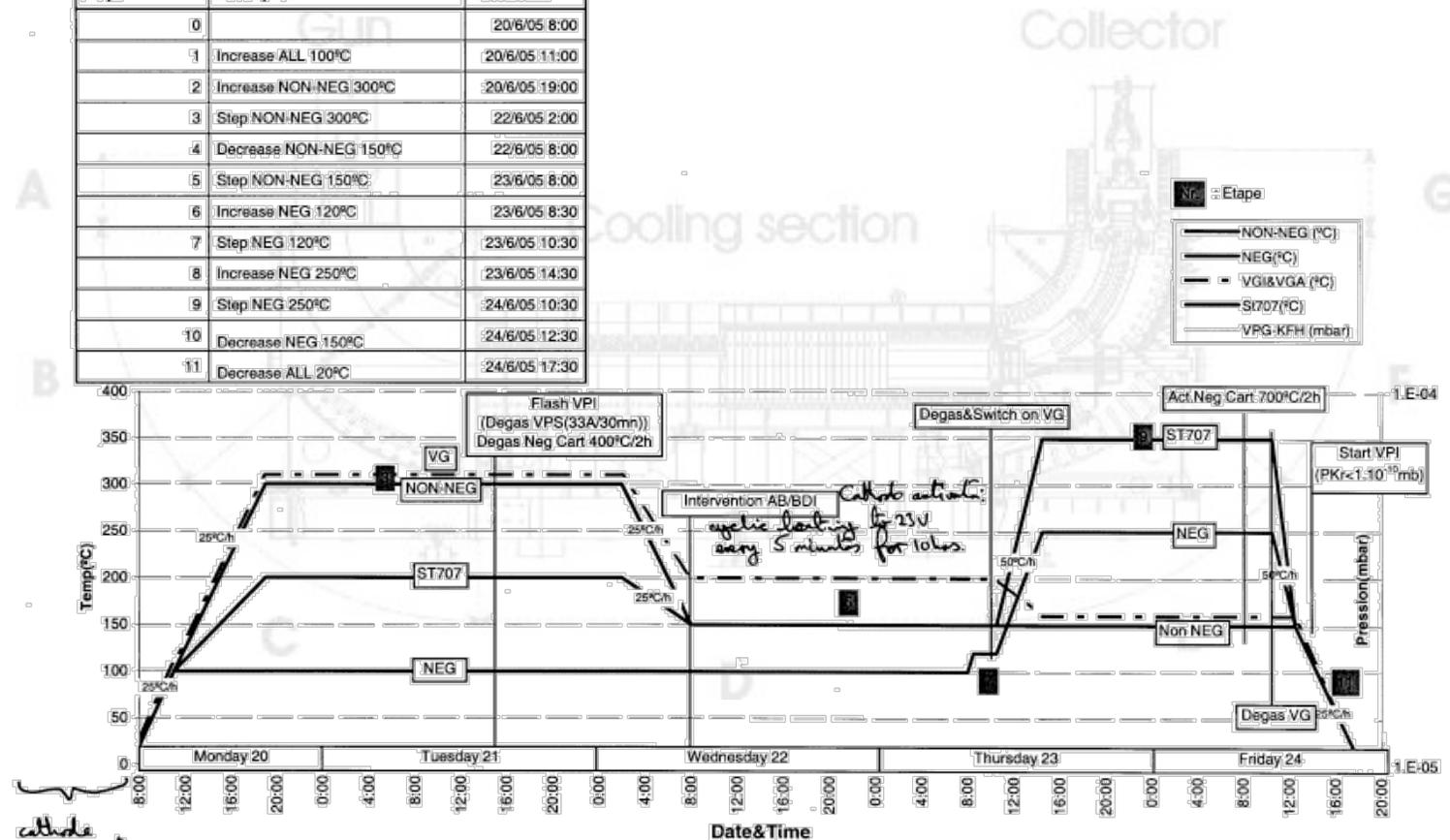
S. Blanchard.Tel. 164537

CERN/AT/VAC/IN Bakeout Applications

13/06/05

Etape	Description	Date&Time
0	Gun	20/6/05 8:00
1	Increase ALL 100°C	20/6/05 11:00
2	Increase NON-NEG 300°C	20/6/05 19:00
3	Step NON-NEG 300°C	22/6/05 2:00
4	Decrease NON-NEG 150°C	22/6/05 8:00
5	Step NON-NEG 150°C	23/6/05 8:00
6	Increase NEG 120°C	23/6/05 8:30
7	Step NEG 120°C	23/6/05 10:30
8	Increase NEG 250°C	23/6/05 14:30
9	Step NEG 250°C	24/6/05 10:30
10	Decrease NEG 150°C	24/6/05 12:30
11	Decrease ALL 20°C	24/6/05 17:30

0506[LEIR] Sector 2 Shedule



*cathode cleaning?
5V-12V in Shop
leave for bakelit*

C:\Documents and Settings\tranquil\Local Settings\Temporary Internet Files\OLK1A2\0506[LEIR-Sec2]BO Shedule.xls, 0503[LEIR]Prog Temp&Pressure



- Bakeout of LEIR sector 2 finished 29th June
- Remounting of the cooler commenced a week later
- Vacuum leak was discovered on a gun ceramic
- Present vacuum level is $6 \cdot 10^{-12}$ torr

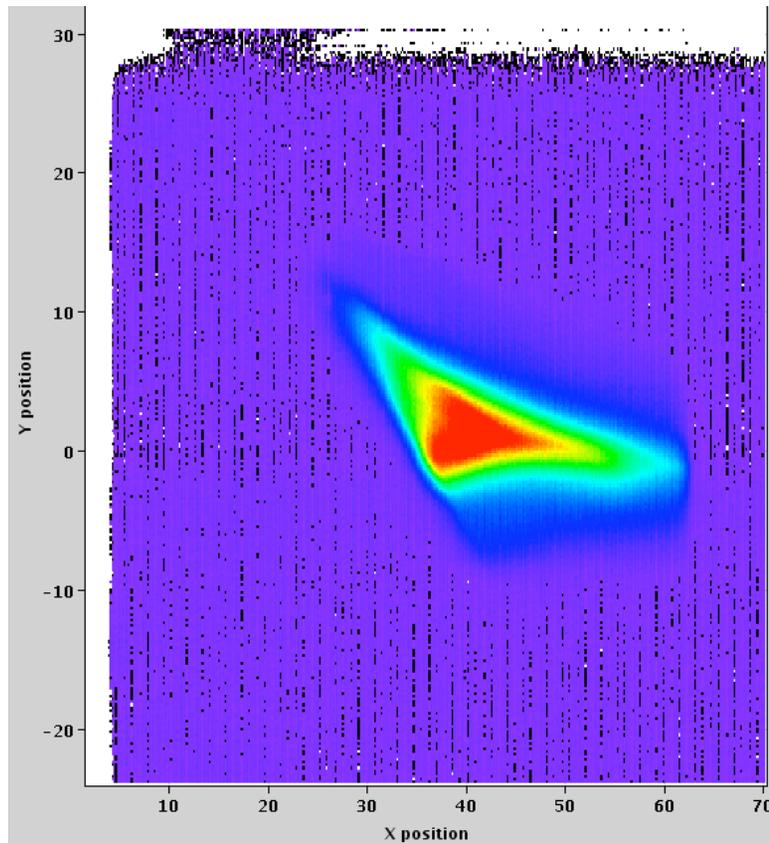


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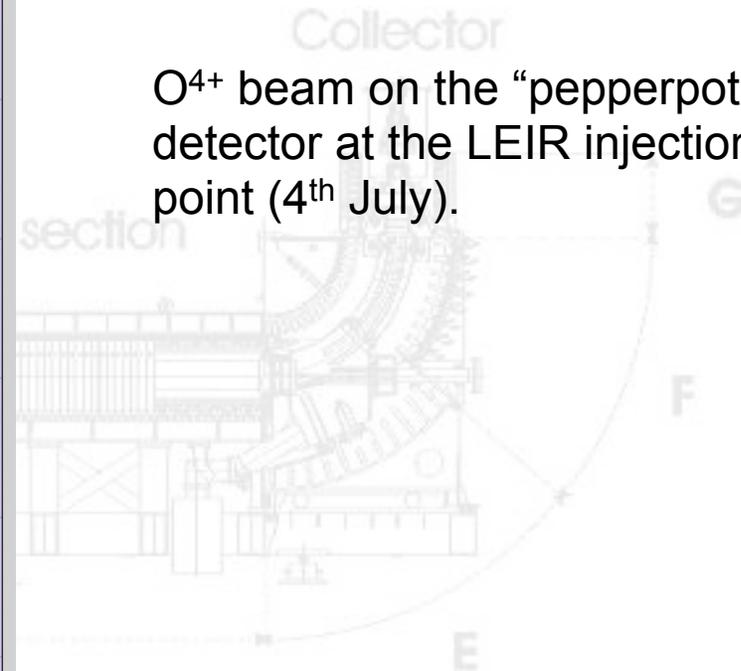


Present status (LEIR)

- Last vacuum sector bakeout was done 10 days ago.
- Still many micro leaks around the machine
 - Average pressure $8 \cdot 10^{-12}$ torr
- LEIR closed for cold check-out last Thursday.
- Since June the injection line has been commissioned with O^{4+} and Pb^{54+} ions.
- Beam-line optics have been checked and are in agreement with theory.
- First injection planned for this week (use O^{4+} and switch to Pb^{54+} in November).



O^{4+} beam on the “pepperpot”
detector at the LEIR injection
point (4th July).



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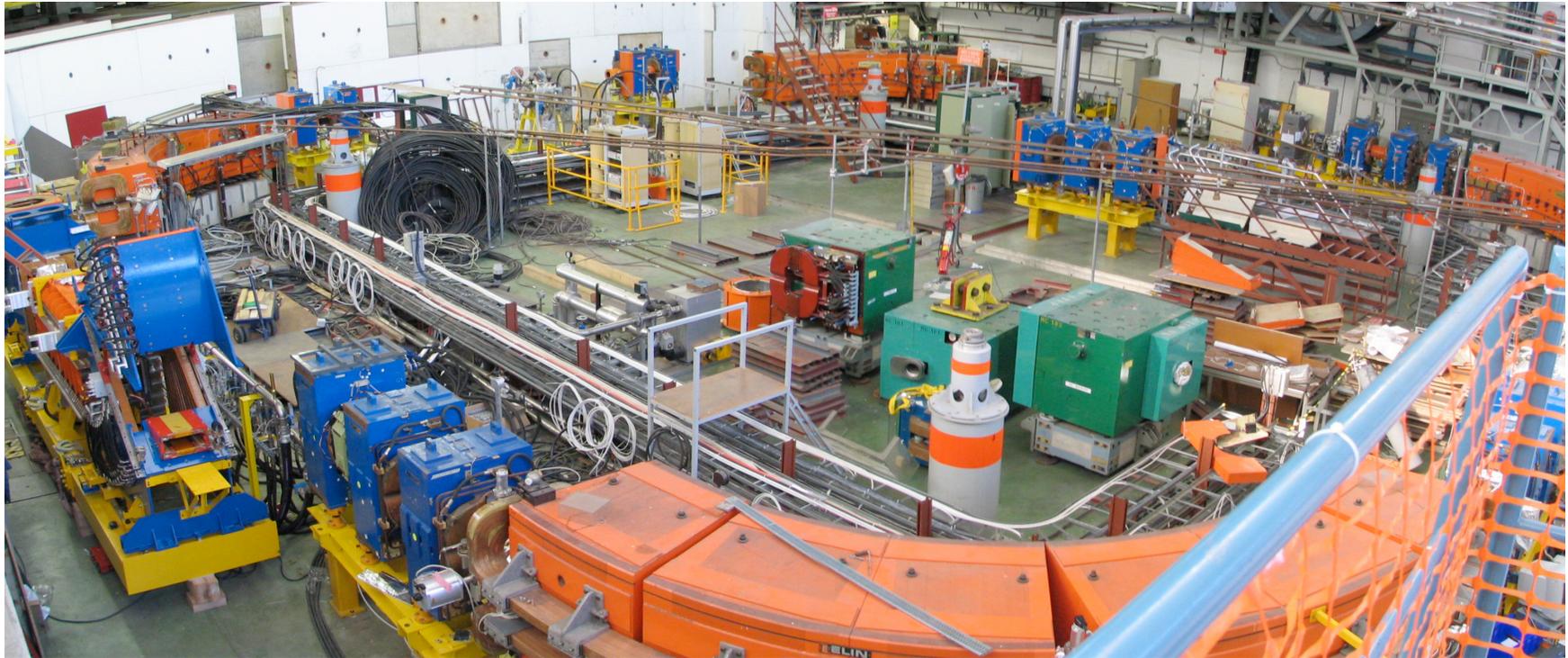
Present status (ECOOOL)



- Some minor mechanical work still needs to be finished.
 - Modify gun enclosure for primary pump installation to contain leak on the gun ceramic.
- HT cabling needs to be finalised in the LEIR ring.
- Commission all HT power supplies and their controls.

Vacuum leak in sector 2 has meant that the cathode needs to be replaced and a bakeout of the sector needs to be done next week.

We still hope to have the first cooling of ions before the end of October



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